## AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions and listings of claims in the application:

1.    (Withdrawn)  A marker locator, comprising:

at least one transmitter channel coupled to provide a transmitter signal to an electromagnetic field generator;

at least one receiver channel coupled to receive time decay signals from an electromagnetic field detector; and

a digital processor coupled to provide digitized transmitter output signals to the at least one transmitter channel and to receive digitized time decay signals from the at least one receiver channel,

wherein the digital processor receives the digitized time decay signals from the at least one receiver channel in the time interval between pulses of application of digitized transmitter output signals to the at least one transmitter channel, the digital processing system averaging the digitized time decay signals received from the at least one receiver channel.

2.    (Withdrawn)  The locator of claim 1, wherein a pulse includes a first period where transmission of the transmitter signal from the electromagnetic field generator occurs and a second period where the time decay signal can be received.

3.    (Withdrawn)  The locator of claim 1, wherein the at least one transmitter channel includes a digital-to-analog converter coupled to receive a digitized transmitter output signal from the digital processor, a filter coupled to receive signals from the digital-to-analog converter, and a driver coupled to receive signals from the filter and provide the transmitter signal to the electromagnetic field generator.

4. (Withdrawn) The locator of claim 1,

wherein the electromagnetic field generator and the electromagnetic field detector are an antenna, and

wherein the at least one transmitter channel includes a transmit switch and the at least one receiver channel includes a receive switch, the transmit switch and the receive switch being controlled by the digital processor such that the at least one receiver channel does not receive the time decay signals while the at least one transmitter channel is coupled to the antenna and the at least one transmitter channel does not transmit the transmitter signal when the at least one receiver channel is coupled to the antenna.

5. (Withdrawn) The locator of claim 1, wherein the at least one receiver channel includes a filter coupled to an analog-to-digital converter, the filter coupled to the electromagnetic field detector to receive the time decay signals and the analog-to-digital converter coupled to the digital processor to provide digitized time decay signals.

6. (Withdrawn) The locator of claim 1, wherein the digital processor includes

a time average that receives the digitized time decay signals from the at least one receiver channel, the digitized time decay signals indicating a signal decay as a function of time following a pulse of the transmitter signal to the at least one transmitter channel, the time average averaging signals over a predetermined number of time intervals between pulses to generate an average decay signal;

a marker search that determines a marker structure from the average decay signal generated by the time average, the marker structure including parameters characterizing at least one marker that reflects signals detected by the electromagnetic field detector;

a detection digital phase locked loop that receives the marker structure, separates a contribution from each of the at least one marker, determines marker parameters for each of the at least one marker, and generates a transmit array ; and

a marker transmit output that generates the digitized transmitter output signal of the pulse based on the transmit array and a pulse repetition clock.

7.      (Withdrawn) The locator of claim 6, wherein the time average utilizes a linear averaging.

8.      (Withdrawn) The locator of claim 6, wherein the time average utilizes an exponential averaging.

9.      (Withdrawn) The locator of claim 6, wherein the time average comprises:

a decay buffer that stores the digitized time decay signals received from the at least one receiver channel;

a summer that adds the signals stored in the decay buffer so that an average is formed over a preselected number of pulses;

a latch that latches that latches signals from the summer into an output buffer to provide the average decay signal; and

a latch output that counts the number of pulses and latches the latch after receipt of the preselected number of pulses.

10.     (Withdrawn) The locator of claim 6, wherein the time average comprises

a plurality of decay buffers to store digitized time decay signals corresponding to a plurality of bits of data from at least one smart marker;

a plurality of summers that add the signals stored in each of the plurality of decay buffers so that an average is formed over a preselected number of pulses;

a plurality of latch outputs that latch signals from the summer into a plurality of output buffers to provide an average decay signal corresponding with each of the plurality of bits; and

a plurality of latch outputs that counts the number of pulses and latches a corresponding one of the plurality of latch outputs after receipt of the preselected number of pulses.

11.     (Withdrawn)  The locator of claim 6, wherein the marker search comprises:

a fast fourier transform that receives the average decay signal from the time average and provides a fast fourier transform signal of the average decay signal;

a marker determiner coupled to receive the fast fourier transform signal and generate a marker structure corresponding to parameters indicating each of at least one identified marker.

12.     (Withdrawn)  The locator of claim 11, wherein the marker structure can include the marker frequency, the marker amplitude, and the marker phase of the at least one identified marker.

13.     (Withdrawn)  The locator of claim 6, wherein the detection digital phase locked loop is coupled to receive the average decay signal and the marker structure, the digital phase locked loop comprising:

at least one marker analyzer coupled to generate a marker strength and marker frequency for a marker and further to remove the effects of that marker from the decay signal, each of the marker analyzers being coupled to receive a decay signal from a previously coupled digital phase locked loop with a first digital phase locked loop coupled to receive the averaged decay signal; and

a transmit output generator, the transmit output generator providing a transmit array for determining a digital transmit signal.

14.    (Withdrawn)  The locator of claim 13, wherein each of the marker analyzers includes:

a digital phase locked loop coupled to receive a decay signal and the marker structure, the digital phase locked loop converging on a current frequency and providing a signal strength, and an error signal corresponding to one marker indicated in the marker structure;

a SDOF curvefit coupled to receive the current frequency and signal strength and generate a marker strength and marker frequency; and

a successive detector generation coupled to receive signals from the SDOF curvefit, generate a marker response, and subtract the marker response from the decay signal to generate a new decay signal for processing by another one of the at least one marker analyzers.

15.    (Withdrawn)  A locator of claim 13, wherein the marker transmit outputs receives the transmit array and provides a time reversal to generate the digital transmit signal.

16.    (Withdrawn)  The locator of claim 15, wherein the digital transmit signal includes signals at frequencies centered around resonant frequencies of each of a plurality of markers.

17. (Withdrawn) The locator of claim 16, wherein the transmit array is arranged to have 0 phase shift for each of the resonant frequencies as measured at an input to the time average.

18. (Previously presented) A method of locating one or more markers, comprising:

generating a series of electromagnetic pulses by generating a transmit signal with resonant frequencies from at least one marker and applying the transmit signal to an electronic marker, wherein the generation of the transmit signal includes:

determining one or more active markers;

determining a marker transmit signal to activate the one or more active markers from a frequency, field strength, and phase, wherein the market transmit signal is phase shifted to provide a delay phase of substantially zero at the end of the electromagnetic pulse;

summing the marker transmit signal to form a digital transmit signal; and

converting the digital transmit signal to form the transmit signal;

receiving signals as a function of time between application of the pulses;

averaging the signals over a predetermined number of pulses to obtain an average decay signal;

initially determining the frequency, field strength, and phase for responses from the one or more markers;

accurately determining the frequency, field strength, and phase by successive elimination of a contribution from each of the one or more markers; and

refining the electromagnetic pulses in order to provide resonant frequencies for each of the one or more markers.

19 - 20.  (Cancelled)


21.  (Previously presented)  The method of claim 18, wherein determining the marker transmit signal further includes

determining a power of the marker transmit signal relative others of the marker transmit signals; and

adjusting the marker transmit signal to the power.


22.  (Previously presented)  The method of claim 18, wherein summing the marker transmit signal includes forming a time reversal signal of the digital transmit signal and time reversing the digital transmit signal.


23.  (Original)  The method of claim 18, wherein initially determining a frequency, field strength, and phase includes:

performing a fast Fourier transform of the average decay signal; and

obtaining initial determinations of the frequency, field strength, and phase of at least one marker from parameters determined in the fast Fourier transform.


24.  (Original)  The method of claim 23, wherein determining the frequency, field strength, and phase more accurately includes:

determining a dominant marker from the initial determinations;

calculating a response from the dominant marker;

removing the response from the dominant marker from the average decay signal; and

determining the frequency, field strength, and phase of at least one marker from the average decay signal with the response from the dominant marker removed.

25. (Withdrawn) A marker locator, comprising:

means for generating pulses of a transmit signal from a frequency, field strength, and phase from one or more markers;

means for receiving signals from one or more markers between applications of the transmit signal;

means for averaging the received signals to form an average decay signal;

means for determining the frequency, field strength, and phase of one or more markers from the average decay signal.

26. (Withdrawn) The marker locator of claim 25, wherein the means for generating pulses includes

means for determining a marker transmit signal for at least one active marker; and

means for generating a digital transmit signal from the marker transmit signal for each of the at least one active marker.

27. (Withdrawn) The marker locator of claim 26, wherein the means for determining the marker transmit signal includes a means for adjusting a power of the marker transmit signal for each of the at least one active marker.

28.    (Currently Amended)  A method of locating one or more markers, comprising:

generating a series of electromagnetic pulses, wherein these pulses can excite multiple types of markers and each type of marker represents a different type of utility line;

receiving signals as a function of time between application of the pulses, wherein the signals are from one or more markers identifying at least one utility line;

averaging the signals over a predetermined number of pulses to obtain an average decay signal;

initially determining a frequency, field strength, and phase for responses from the one or more markers;

accurately determining the frequency, field strength, and phase by successive elimination of a contribution from each of the one or more markers; and

refining the electromagnetic pulses in order to provide resonant frequencies for each of the one or more markers, wherein the accurate determining and the refining assists in the capability to distinguish a particular type of one or more markers from the different types of markers.

29.    (Previously presented)  The method of claim 28, wherein generating a series of electromagnetic pulses includes:

generating a transmit signal with resonant frequencies from at least one marker;

applying the transmit signal to an electromagnetic generator.

30.    (Previously presented)  The method of claim 29, wherein generating the transmit signal includes:

determining one or more active markers;

determining a marker transmit signal to activate the one or more active markers from a frequency, field strength, and phase, wherein the market transmit signal is phase shifted to provide a delay phase of substantially zero at the end of the electromagnetic pulse;

summing the marker transmit signal to form a digital transmit signal; and

converting the digital transmit signal to form the transmit signal.

31.     (Previously presented)  The method of claim 30, wherein determining the marker transmit signal further includes

determining a power of the marker transmit signal relative others of the marker transmit signals; and

adjusting the marker transmit signal to the power.

32.     (Previously presented)  The method of claim 30, wherein summing the marker transmit signal includes forming a time reversal signal of the digital transmit signal and time reversing the digital transmit signal.

33.     (Previously presented)  The method of claim 28, wherein initially determining a frequency, field strength, and phase includes:

performing a fast Fourier transform of the average decay signal; and

obtaining initial determinations of the frequency, field strength, and phase of at least one marker from parameters determined in the fast Fourier transform.

34. (Previously presented) The method of claim 33, wherein determining the frequency, field strength, and phase more accurately includes:

determining a dominant marker from the initial determinations;

calculating a response from the dominant marker;

removing the response from the dominant marker from the average decay signal; and

determining the frequency, field strength, and phase of at least one marker from the average decay signal with the response from the dominant marker removed.


35. (Currently Amended) A marker locator for detecting and determining the location of one or more markers that identify a utility line, the locator comprising:

an antenna that provides a series of electromagnetic pulses and receives signals as a function of time between application of the pulses, wherein these pulses can excite multiple types of markers and each type of marker represents a different type of utility line and the signals are from one or more markers identifying at least one utility line; and

a processor that averages the signals over a predetermined number of pulses to obtain an average decay signal, initially determines a frequency, field strength, and phase for responses from the one or more markers, and accurately determines the frequency, field strength, and phase by successive elimination of a contribution from each of the one or more markers, wherein the accurate determining assists in distinguishing a particular type of marker from the different types of markers.